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**The Relation of Topics and Themes in
Naturally Occurring Technical Paragraphs**

David E. Kieras
University of Arizona

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Technical Report No. 1

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Abstract

There is a distinction between two kinds of thematic information in a passage: the main item, or topic, and the main idea, or theme. Although these are distinct kinds of information, the main idea should be about the main item. Separate groups of subjects generated title-like noun phrase identifications of topics, and simple sentence statements of themes, for paragraphs from Scientific American. Most theme statements contained one of the topics, with a frequency related to the popularity of the topic. Furthermore, theme statements most often contained a topic as the surface sentential subject. These results show that although identifying the main item and identifying the main idea are different tasks with different processes involved, there is a close correspondence between the two types of thematic information identified by readers.

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Thematic information, the knowledge of the topic or theme of a passage, is given an important role in currently developing theories of reading comprehension. According to these theories, this thematic information is used by the reader to assist in the integration of passage content (Kieras, 1977; Carpenter & Just, 1977), and to guide the storage and retrieval processes (Kozminsky, 1977; Meyer, 1977). However, most of the extant work on thematic information has been concerned with how such information is used by the reader, especially in recall. Relatively little attention has been given to how the reader identifies thematic information during reading, and what the properties of thematic information are.

The terms topic and theme tend to be used interchangeably to refer to what a passage is about. However, a distinction needs to be made between the main idea conveyed by a passage, and the main referents, the objects or items that the passage contains information about. According to common usage and the dictionary, the meaning of the term theme is similar to main idea, and that of topic is similar to main referent. This paper uses topic and theme in these senses.

An example will quickly make the distinction clear. Table 1 is a paragraph taken from a Scientific American article. Consider the question, "What is this passage about?" The main idea seems to be Timekeeping accuracy has improved; but the main item being described seems to be Timekeeping devices. Hence a topic is one of the objects, or class of objects, that the passage makes statements about. A theme is the most

Table 1

Example Paragraph

The accuracy of timekeeping has improved by nine orders of magnitude over the past two centuries, with more than half of the improvement coming in the past 25 years. A good 18-th century chronometer could run for a week or two without gaining or losing more than a second. By 1945 quartz-crystal clocks had been developed that would maintain one-second accuracy for several years. Today's hydrogen masers are stable to better than two parts in 10 to the 15th over 24 hours. If the error in the rate of such a maser remained constant, a gain or loss of one second would take more than 10 million years.

important statement conveyed, either explicitly or implicitly, by the passage.

Current theories of memory mirror the distinction being made here between topics and themes. Systems such as that of Kintsch(1974) would represent the above theme example as one or more propositions, represented with a logic-like notation as

(IMPROVE, SOMEONE, ACCURACY)(TIMEKEEPING, ACCURACY)

Here, IMPROVE appears as the relation, or predicate, applying to an argument, ACCURACY. On the other hand, a topic would appear as one of the arguments appearing in the passage, or an argument designating a superset for several such arguments. Likewise, in network models of memory (e.g. Anderson & Bower, 1973; Norman & Rumelhart, 1975), knowledge is represented as a network of links interconnecting nodes; a proposition is a link, or a set of links, depending on details of the representational system, and concepts or referents are represented by the nodes. Hence the topic of a passage whose content was represented in memory would be one of the nodes, while the theme would be one of the links or set of links representing a proposition.

How is Thematic Information Identified? If the reader is to use thematic information, he or she must have some means of identifying what in the passage is thematic. One way to do this is to fully or deeply comprehend the passage content by relating it to long-term memory and applying rules such as van Dijk's (1977a, 1977b) macro-structure rules to arrive at the thematic

information. For example, a rule similar to van Dijk's GENERALIZATION rule could be used to identify a superordinate for passage arguments, and thus determine a topical concept. The CONSTRUCTION, INTEGRATION, or DELETION rules could be used to locate or derive a macro-proposition from which the passage propositions follow, or which the passage propositions entail; such a proposition could be used as a basis for a statement of the main idea.

However, it must be possible for the reader to identify at least some thematic information without engaging in full comprehension, but on the basis of fairly superficial features of the passage. This follows from the notion that one of the functions of thematic information is to guide integration processes. That is, the reader can not perform deep comprehension processes without first performing the basic step of assembling the content of individual sentences together. If thematic information is used to assist this first step, it follows that the reader can obtain some thematic information very early in the comprehension process, before deep comprehension takes place. Some examples of features of a passage that would function in this way are titles (Kozminsky, 1977; Dooling & Mullet, 1973; Bransford & Johnson, 1972), initial appearance of theme sentences (Thorndyke, 1977; Meyer, 1977; Kieras, 1978), and frequent mention of the topic (Perfetti & Goldman, 1974, 1975).

Relation of Topics and Themes. If it is granted that topics and themes are different types of thematic information, the question immediately arises concerning their relation to each other. A simple, but substantive, hypothesis is that themes tend to be about topics. That is, the theme is a proposition that includes the topic as an argument. Since in English the surface subject of a sentence is normally the sentence topic (see Carpenter & Just, 1977; Perfetti & Goldman, 1974), the passage topic should thus appear as the surface subject in a statement of the passage theme.

This hypothesized relation appeared clearly in very simple passages in unpublished studies by the author and in Kieras (1978). Subjects read very simple passages one sentence at a time, and then wrote down the sentence that "would make the best title." The favorite theme choice was the sentence stating the proposition that in terms of the connectivity in the passage structure, was most central. The most popular other choices were the sentences in which the surface subject was the same argument that appeared as surface subject of the central proposition sentence. Hence theme choices were mainly those which contained a particular argument as surface subjects. Studies in which subjects were told to pick a topical argument (one of the nouns) show that this same argument was the most popular topic. Hence, the most popular theme statements contained the most popular topic choices as a surface subject.

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The primary question addressed in this study is whether the hypothesis that themes tend to be about topics could be demonstrated in natural passages of some realistic complexity. Passages from Scientific American were used (Table 1 is an example) because similar materials have been used before (e.g., Kintsch, Kozminsky, Streby, McKoon, & Keenan, 1975), and because the study of the comprehension of descriptive technical prose has some direct applied value.

The basic approach in this study simply was to present a large number of paragraphs to subjects and have them produce either a sentence stating the theme of the paragraph, or a word or phrase stating the topic. The theme and topic responses thus obtained were then compared to each other. However, previous work has indicated that if subjects are allowed too much leeway in devising theme or topic statements, their responses are likely to be extremely idiosyncratic. This is what would be expected to occur from the application of powerful macro-structure rules to the highly idiosyncratic contents of memory. For this reason, the subjects were constrained to choosing as a topic or theme something "actually mentioned" in the passage. Subjects did not follow these instructions to the letter; many responses were paraphrases, generalizations, or inferences, based on the passage content. However, this constraint did have the effect of encouraging responses that were fairly consistent across subjects, and which could be analyzed in terms of the passage content, and compared to each other. Hence these results should be viewed as conveying information about what subjects choose as a topic or theme when

they must stay relatively close to the passage content; attacking the problem of what they choose when allowed free rein must wait.

A secondary goal was to develop a practical methodology for studying thematic identification processes in complex natural prose. Problems to be solved were whether subjects would give stable data, and how their responses could be analyzed without recourse to propositional analysis of the passages (see Kintsch, 1974; Turner & Greene, Note 1). In order to arrive at useful generalizations about natural prose it is necessary to study a large sample of passages; the large amount of time and effort involved in performing a full propositional analysis of each passage would not be justifiable in the first studies on the problem.

Another secondary goal was to gain some information on how subjects identify thematic information in such passages. Based on the earlier work mentioned above, the first-appearing sentence should be associated with thematic content. Also, the macro-structure rules suggest that the process of arriving at a thematic proposition may well be more complicated than arriving at a thematic argument, meaning that theme identification should take longer than topic identification. Furthermore, the more complex inferences involved in arriving at a theme would seem to depend more on the idiosyncratic contents of the reader's memory. So, there should be more variability between subjects on theme choices, compared to topic choices.

Method

Materials. The passages were complete verbatim passages from recent articles appearing in Scientific American. An initial pool of about 100 paragraphs were selected that (a) were between 1.75 and 2.5 inches long in print; (b) appeared to be about one basic thing, although several arguments (in Kintsch's sense) and their relations were typically described; (c) could stand alone; that is, the paragraphs appeared to be comprehensible out of the original context of the article. From this pool, 30 passages were selected that more definitely met the above constraints and were also 2 to 2.5 inches long in print. The passages were photoduplicated onto slips of paper, and assembled into booklets containing one passage per page, with the 30 passages appearing in random order in each booklet.

Design and Subjects. Two groups of 30 subjects were used in a between-subjects design for the two instruction conditions.

The Topic Group was instructed to produce a topic choice, the Theme Group produced statements of the theme. Subjects were assigned to an instruction group according to order of appearance for the experiment, with subjects being assigned to a given condition alternately. Subjects were University of Arizona students of both sexes recruited through campus advertisements. They were paid \$2.00 for participating.

Instructions. The theme and topic instructions were prepared to be very similar except for the requirements and constraints for responses. The Topic Group instructions were to produce a word or phrase naming a topical argument. The instructions stated that subjects should provide for each passage a "judgment of what object or thing best represents what the passage is about Write down a simple title or phrase that names this thing." A set of specific rules were provided for the "title response," with examples of right and wrong responses supplied: (1) "It must name a single thing, not two or more things mentioned in the passage." (2) "It must be a single word or short phrase, not a sentence." (3) "...it must name or designate something that was ACTUALLY MENTIONED in the passage." The third rule was elaborated to encourage subjects to view the process as selecting a topic from the passage rather than "making up" a "creative" title "based on conclusions or inferences."

The theme instructions stated that subjects should produce "a single simple sentence that states what you think is the most important idea actually expressed in the passage." A set of rules was provided for this "main idea sentence" with examples of right and wrong responses: (1) "It must be a single sentence, not two or three." (2) "It must be a simple sentence that fits into the space provided on the page underneath the passage." This rule encouraged brief statements rather than complex all-inclusive summaries. (3) "It must be a complete sentence, not a word or phrase." (4) "... your sentence must express an idea that was actually mentioned in the passage."

This rule was elaborated as in the topic instructions, with the addition that "this does not mean that we want you to simply copy a sentence from the passage; your response should express the main idea in a simple compact form. Sometimes actual sentences from the passage will do this, but most of the time they won't."

Procedure. Subjects were run in groups of two or more in a large room with several tables. The subjects in the different instruction conditions were seated separately, and were separately instructed in order to minimize confusion over the instructions. Consequently, subjects were usually aware that different instruction conditions were being used. After reading a written set of instructions, subjects were questioned by the experimenter to ensure understanding. Then subjects proceeded through their booklets at their own pace, writing their theme or topic response on the booklet pages below the passage. The first few responses from subjects were usually checked by the experimenter to ensure that the subject was producing responses that met the form constraints for the instruction condition. On the relatively few times when subjects were violating the instructions, the relevant parts of the written instructions were pointed out to the subject, and the form rules emphasized. This intervention was never performed after the subject had progressed past the first few passages. Approximate starting and stopping times were recorded for most subjects, with some haphazard failures to record this information when large numbers of subjects were present.

Results and Discussion

Since several aspects of the data were examined, using different procedures for scoring the responses, the results will be described and discussed here in a step-by-step fashion. Many of the statistical tests were performed using only passages as a random factor. In several such cases where subjects were not represented in the analysis, such representation would carry no conventional statistical interpretation. Furthermore, tests were done on the distribution of responses totalled across subjects. The statistical approach in such cases was that the pool of responses from the two groups was a large sample from the populations of possible theme and topic responses, and inferences are made to the population so defined. It is known that in a balanced within-subject design in which multiple responses are obtained from each subject, and the choices aggregated across subjects, a chi-square statistic computed on the resulting aggregated contingency table will be "too small," and thus yields a conservative test in attempting to reject the null hypothesis (J. E. K. Smith, personal communication). Hence the statistical tests to be reported, while perhaps somewhat unorthodox in appearance, are in fact appropriate and give a correct characterization of the results.

Completion times. Starting and stopping times were completely recorded for 25 Topic Group subjects and 26 Theme Group subjects. Topic subjects required an average of 39 minutes to complete the task, while Theme subjects required 61

minutes ($t(49)=3.63$, $p<.001$). This corresponds to an average difference between the two groups of 44 seconds on each passage. Once a response had been composed, it is doubtful that more than a few seconds would be required to write down a short sentence as opposed to a short phrase. Hence for these passages it must take on the order of 40 secs longer to devise a theme response than a topic response, indicating that a substantially larger amount of processing is required to identify the main idea rather than simply the main referent.

Response categorization. The verbal responses supplied by the subjects were scored by means of a simple categorizing system, described as follows: The booklets were dismantled and the pages regrouped by passages. Each page thus had a single subject's response to a single passage. For each passage, the responses were sorted into categories that met the simple criterion of simply belonging together in terms of similarity. The theme and the topic responses were sorted separately. No restrictions were placed on the number of categories or the number of responses in each. Single member categories were thus defined if needed. Preliminary trials indicated that this method was fairly reliable in that there was a high degree of similarity between responses in the same category. One person thus performed the categorizations for all responses. It should be noted that a different person performed all subsequent scoring in the matching analyses reported below. Once the categories had been defined, the sorter picked a typical instance from each category to serve as the prototype of the category. Thereafter, the entire set of responses in that

category were represented by the prototype. An example of the topic and theme categorizations is presented in Table 2, which shows the category prototypes and frequencies for the responses to the passage in Table 1. The categorizations yielded 198 different topic choice categories and 246 theme categories. This approach, of working with the response data in terms of the prototype for each category, and the frequency of responses in that category, considerably simplified the data analysis compared to attempting to deal with the 1800 separate responses.

Approximately 9% of the topic choices and 4% of the theme choices were categorized as errors, in that the subject produced a response clearly inconsistent with the form constraints specified by the instructions, such as writing down a phrase rather than a complete sentence in the theme condition. Such errors were mostly produced by a very few subjects who simply failed to follow instructions.

The average number of categories for topic responses was 6.6, with a range of 3 - 12. The mean for theme responses was 8.2, with a range of 3 - 18. The difference in means was tested, assuming passages to be a random factor, and was significant ($t(29)=2.138$, $p<.05$). This suggests that theme responses were less consistent than topic responses, an intuitively appealing result, given the greater complexity of theme identification processing. But such a conclusion is rather heavily qualified by the fact that the criteria used to determine the number of response categories may not have been the same for the themes and the topics.

Table 2

Example of Topic and Theme Categorizations

| Topic Categorization | |
|----------------------------|----------|
| Topic Prototype | <u>f</u> |
| A. Timekeeping accuracy | 9 |
| B. Timekeeping | 8 |
| C. Improved timekeeping | 4 |
| D. Timekeeping history | 4 |
| E. Timekeeping devices | 2 |
| F. Chronometer improvement | 1 |
| Errors | 2 |

| Theme Categorization | |
|---|----------|
| Theme Prototype | <u>f</u> |
| Timekeeping accuracy has increased greatly over the years. | 26 |
| Hydrogen masers are an incredibly accurate way to measure time. | 1 |
| Modern clocks are better timekeepers. | 1 |
| We can now keep time incredibly accurately. | 1 |
| Errors | 1 |

Another way to look at the consistency of responses within passages is the extent to which the distribution of responses over the categories differs from a flat distribution. This was examined by computing a chi-square goodness-of-fit statistic for each passage, with expected frequencies specified by a uniform distribution over the same number of categories. For the topic responses, 17 of the 30 passages produced significant ($p < .05$) non-flat distributions. For the theme responses, 20 of the 30 were significantly non-flat. These proportions are not significantly different, suggesting similar degrees of within-passage consistency for the two instruction conditions. However, this conclusion, which tends to contradict the one stated above, must be qualified on the same basis. Hence these results do not allow a firm conclusion on the relative consistency of topic and theme responses.

Topic and Theme Sources. The prototype topic responses were compared to the original passages and classified by a rater into four categories: (1) Exact Reference: The topic response has the same wording as a referent mentioned in the passage. (2) Same Referent: The topic response referred to the same referent, but with different wording. (3) Implied Referent: The topic response named an object strongly implied or generalizable from the passage. (4) Weakly Implied Referent: The topic response was only weakly related to the passage. Table 3 shows the proportions of topic choices falling into each classification by this scheme, both unweighted and weighted by the frequency of the topic choice. Hence the unweighted figures convey information in terms of the number of topic choice

Table 3

Distribution of Generality Ratings for Topic Choices

| Rating | Unweighted | Weighted |
|------------------|------------|----------|
| Exact Reference | .41 | .61 |
| Same Referent | .37 | .30 |
| Implied Referent | .20 | .08 |
| Weakly Implied | .02 | .01 |

prototypes, but the weighted figures convey information in terms of the number of actual individual topic choice responses.

Referring to the unweighted proportions, a large number (20%) of topic choice prototypes were implied, but when the relatively low frequency of responses of this type is taken into account as in the weighted proportions, it is seen that only about 8% of the total topic choices were implied referents. Likewise, 91% of the total choice responses were of exact reference or same referent. This means not only that subjects followed the topic condition instructions, which stated that the topic had to be actually mentioned in the passage, but also that subjects apparently found it easy and reasonable to conform to this rule.

The prototype theme responses were compared to the original passage, but were classified in terms of which sentence or sentences in the original passage they resembled. The wording and content of the theme prototype was compared to each sentence in the passage. If the theme prototype could be considered a subset of the wording and content of a single one of the passage sentences, it was classified as being taken from that sentence in the passage. If the theme contained wording or content from more than one of the passage sentences, it was classified as an integrative response. If it could not be identified as coming from a particular set of sentences, it was classified as unrelated. Since the passages had different numbers of sentences, Table 4 shows the distribution of theme sources for passages of all lengths, and the average distribution both

Table 4
Proportion of Theme Choices from Each Sentence Position

| Number | Sentence Position | | | | | | Integ. | Unrel. |
|-----------------|-------------------|-----|-----|-----|-----|-----|--------|--------|
| | 1 | 2 | 3 | 4 | 5 | 6 | | |
| 1 | .77 | .07 | | | | | .10 | .07 |
| 6 | .25 | .18 | .33 | | | | .19 | .05 |
| 12 | .33 | .11 | .16 | .15 | | | .22 | .03 |
| 10 | .28 | .09 | .14 | .05 | .08 | | .32 | .04 |
| 1 | .30 | .00 | .27 | .00 | .00 | .00 | .33 | .10 |
| Unweighted Mean | .39 | .09 | .23 | .01 | .04 | .00 | .23 | .06 |
| Weighted Mean | .30 | .11 | .19 | .10 | .07 | .00 | .24 | .05 |

Note. The columns labelled Integ. and Unrel. indicate the proportions of theme choices that were scored as Integrated or Unrelated.

unweighted, and weighted by the number of passages of each length.

Almost all of the responses (about 94%) could be found in the passage, which means both that subjects were able to follow the instructions to pick a theme that was actually mentioned, and also that they found it reasonably easy to do so. The bulk of the responses (about 70%) are taken exclusively from one of the passage sentences; most of the remainder were integrative responses combining content from more than one of the passage sentences. The theme condition instructions explicitly permitted integrative responses; hence the large number of them is consistent with the instructions, but the fact that a single sentence was usually the theme source indicates that subjects usually found this to be an adequate source of information about the main idea.

Another feature of the results in Table 4 is an apparent preference for sentences in the first and third positions. This feature was tested by applying chi-square goodness-of-fit tests comparing a flat distribution to the obtained distribution of single sentence source frequencies (integrative and unrelated responses were not included) for each passage length. These chi-square values were all significant well beyond the .01 level except for passages of length 3, which was significant at only the .05 level. Hence, for all passage lengths, the apparent preferences for serial position are reliable. Whether position one appeared more often than position three was tested, using the frequencies for individual passages, and found to be

nonsignificant ($t(28)=1.15$). Hence the first sentence is overall the favorite source of themes, which makes sense in terms of common usage and other data (e.g. Kieras, 1978), but apparently the third sentence in these passages carries content subjects consider to be thematic just as often.

Relation of Topics and Themes. In order to test the major hypothesis of this study, that theme sentences tend to mention topics, especially as the sentential subject, a method was devised for comparing theme noun phrases and topic responses. The basic approach was to extract a main and a secondary noun phrase from each theme prototype; these theme noun phrases were then compared to the topic prototypes and the frequency of matches under certain criteria was counted.

In more detail, each theme prototype was first simplified by deleting any subordinate clauses, and then parsed according to a simple sentence grammar represented as an Augmented Transition Network (see Anderson, 1976, or Kieras, 1977) to identify the individual noun phrases and clauses in the theme prototype. Then, to select the main and secondary noun phrases, the following algorithm was followed: The subject noun phrase of the main clause was designated as the main noun phrase. The highest level noun phrase in the predicate of the main clause, if present, became the secondary noun phrase. If there were no such main predicate noun phrase, the highest noun phrase in any modifying clauses in the subject noun phrase was designated as the secondary noun phrase. If there was no such noun phrase, no secondary noun phrase was designated. As an example, for the

theme prototype Modern agriculture has increased the flow of nutrients through the food cycle, the main noun phrase is Modern agriculture, the secondary noun phrase is The flow of nutrients. The main and secondary noun phrases of all of the 246 theme prototypes were thus extracted.

The pair of theme noun phrases for each theme sentence was then compared to the topic prototypes for that passage. In this process, a theme prototype was allowed to match a topic prototype only on one of the two noun phrases; matches on both main and secondary noun phrases were not permitted. Rather, the single best matching of the two was used. Four hierarchical criteria for the quality of the match between theme noun phrases and topic prototypes were used. These were hierarchical in the sense that the criteria went from very close matches to simply related content, and if a particular theme-topic prototype pair was matched under a high quality criterion, it would not be available for matching under a low criterion. Hence the criteria formed a mutually exclusive set of categories of matches, and each pair of items being matched would be classified only under the highest quality match possible. The four criteria, in order of descending quality, were as follows:

- (1) An Exact match was scored if the prototype theme noun phrase was exactly like the topic prototype or a very close paraphrase.
- (2) A Gist match was scored if the same referent was referenced, but not as closely as is the Exact criterion.
- (3) An Overlap match was scored if the theme and topic shared words or concepts, but the same referent was not present.
- (4) The lowest grade, a Related match, was scored if the topic prototype and

the theme prototype noun phrase were related in terms of meaning, but without overlap of concepts. Any theme-topic pairs not meeting one of these four criteria was classified as no match.

The matching was done as follows: For each topic choice prototype the theme prototypes matching on the main or secondary noun phrase were determined under the exact criterion. A given theme prototype was allowed to match a topic only once, either with its main or secondary noun phrase, but not both. The total frequency of the theme responses for all of the matching prototype categories was then recorded under the classification of an Exact match on the main (or secondary) noun phrase. This gave the total number of theme responses generated by subjects that included a noun phrase matching that topic prototype. Then, for the same topic prototype, the number of Gist matches were determined; theme noun phrases previously classed as Exact matches were disqualified for Gist or lower matches. This process was repeated for the topic prototype until all theme prototypes had been assigned a matching category. Then the next topic prototype for the passage was similarly matched to all of the theme prototypes for that passage. Table 5 contains an example of the matches classified for the topic and theme choices shown in Table 2.

The resulting tabulation showed for each of the 198 different topic choice prototypes, how many theme responses (not prototypes) matched the topic prototype, and whether it matched on the main or secondary noun phrase. The hierarchial match

Table 5
Example of Theme Matching to Topics

| | | Matching Criterion | | | | | | | | | |
|-------|-------|--------------------|---|------|---|---------|---|---------|---|----------|--|
| | | Exact | | Gist | | Overlap | | Related | | No Match | |
| Topic | Freq. | M | S | M | S | M | S | M | S | | |
| A | 9 | 26 | - | - | - | - | - | - | 3 | 0 | |
| B | 8 | - | - | - | - | 26 | - | - | 3 | 0 | |
| C | 4 | - | - | - | 1 | - | - | 26 | 2 | 0 | |
| D | 4 | - | - | - | - | - | - | 26 | 3 | 0 | |
| E | 2 | - | - | - | - | - | - | 26 | 3 | 0 | |
| F | 1 | - | - | - | 1 | - | - | 26 | 1 | 1 | |

Note. The columns labelled M and S show the number of matches on Main and on Secondary noun phrases, respectively.

quality criteria form a mutually exclusive set of match categories that allow the assessment of how close the matches were. But it should be kept in mind that the themes matching under the lower criteria (e.g. Related) are only those that did not match under a higher criterion.

Table 6 shows the distribution of matches of theme noun phrases to topic prototypes, both weighted and unweighted by the topic choice frequencies. Considering the unweighted match distribution, the total number of possible matches is 5940; there were 198 different topic choice prototypes and 30 theme responses, one from each Theme Group subject, that could be matched to each topic prototype. Due to the small proportion of errors not included in the matching process, the actual total number of matches is 5756. Note that this unweighted data does not take into account that some topic prototypes represent topic choice categories that were more popular than others. Therefore, also shown in Table 6 is the distribution of theme-topic matches weighted by the frequency of each topic category. For example, if 10 theme responses matched a topic choice prototype representing a category containing 5 topic responses, the contribution from this match is 50 matches. The total number of such weighted matches, error responses not included, was 23,741. This distribution represents the matches with the topic frequency taken into account. It should be noted that very few matches appeared under the Gist criterion, reflecting the property of the responses that matches were either close, fitting the Exact criterion, or relatively loose, fitting only the Overlap or Related criteria. Few Gist matches

Table 6

Classification of Theme Noun Phrase Matches to Topics

| | Exact | Gist | Overlap | Related | NonMatch |
|-------------------|-------|------|---------|---------|----------|
| <hr/> | | | | | |
| <u>Unweighted</u> | | | | | .27 |
| Main NP | .10 | .04 | .24 | .18 | |
| Secondary NP | .02 | .01 | .08 | .07 | |
| <hr/> | | | | | |
| <u>Weighted</u> | | | | | .19 |
| Main NP | .25 | .05 | .23 | .14 | |
| Secondary NP | .04 | .01 | .06 | .05 | |
| <hr/> | | | | | |

thus appeared.

It is clear from the Table first of all that the bulk of theme responses were definitely related to topic responses; 73% unweighted, or 81% weighted, of theme responses matched the topics under one of the matching criteria. If matches are combined over criteria, 55% unweighted, 66% weighted, of them are on the main noun phrase of the themes, and only 18% unweighted, or 15% weighted, of them are on the secondary noun phrase of the themes. This result confirms the prediction that theme statements would contain the topics as their sentential subject. Evaluating this result statistically was done as follows: (a) A goodness-of-fit test was performed comparing the obtained distribution of main matches, secondary matches, and nonmatches to a null distribution which had the observed frequency of nonmatches, and equal frequencies for main and secondary matches. Obtained chi-square values were 1091 for the unweighted matches, and 7458 for the weighted matches. This extremely significant result indicates that the apparent higher match frequency to main noun phrases than to secondary noun phrases is reliable. (b) Twenty-six out of the 30 passages show more matches on theme main noun phrases than on secondary noun phrases, on both weighted and unweighted matches, which is significant by the sign test ($p < .001$) in both cases.

From the above results, theme responses tend to use popular topic responses as their sentential subjects. One further analysis was done to demonstrate that the more often a referent was chosen as a topic, the more often it appeared as a theme

noun phrase. This was done by correlating the topic category frequencies with the number of theme responses matching that topic category. The correlation was computed for each type of match criterion for both main and secondary noun phrases. These correlations are shown in Table 7, under the Criteria Separate heading. Because of the hierarchial scheme used for match scoring in which the quality criteria categories were mutually exclusive, the pattern of correlations requires some explanation.

First, note that the Nonmatch criterion shows a significant negative correlation, meaning that failures of themes to match topics were associated with the less common topics. That is, the more common the topic, the more often themes contained a noun phrase that matched the topic. Considering next the Exact match criterion, there is a strong positive correlation which means that very close matches occurred most often to the frequent topics. The other criteria show different degrees of relationship between topic and theme matching frequency, but this is largely due to the fact that the categories were exclusive. Hence, for example, the negative correlation under the Related criterion is produced by the fact that if a theme was fairly odd, or unusual, it would be unlikely to match in the Exact or other higher criteria, but would have a good chance of being related to the more unusual, uncommon topics.

One way to get a clearer picture of how the relation between topics and theme noun phrases depends on the different scoring criteria is to combine the matching criteria so that

Table 7

Correlation of Topic Frequency with Theme Match Frequency

| | Exact | Gist | Overlap | Related | NonMatch |
|----------------------------|--------|--------|---------|---------|----------|
| <u>Criteria Separate</u> | | | | | -.244** |
| Main NP | .614** | .049 | -.019 | -.138* | |
| Secondary NP | .141* | -.076 | -.097 | -.110 | |
| <u>Criteria Aggregated</u> | | | | | |
| Main NP | .614** | .555** | .365** | .267** | |
| Secondary NP | .141* | .108 | -.026 | -.096 | |

* $p < .05$; ** $p < .01$

each one includes not just matches at that level of quality, but also all higher quality matches. Table 7, under the Criteria Aggregated heading, shows the correlations between topic choice frequency and matching frequency where the match frequencies have been totaled for all criteria at or higher than the specified one. So for example, the Overlap criterion contains all matches at Exact, Gist, and Overlap criteria. It can be seen that as the criterion for a match is made looser, the strength of the relation between topics and theme noun phrases weakens. However, even under the loosest criterion, there is still a significant positive relationship between topic frequency and theme noun phrase match frequency. However, the secondary noun phrase relation to topic choices is much weaker initially, and shows up only if the closest matches are considered. Hence, the conclusion that topics tend to appear as sentential subjects of theme statements is further supported by the close relationship between the popularity of a topic and the number of themes that use it.

Conclusions

The methodology used in the study appear to have been adequate for the level of detail desired. The instructions to choose something actually mentioned in the passage was not taken too literally by the subjects, in that many responses were not verbatim excerpts from the passage. However, the instructions were followed adequately enough to ensure that the responses could be related to the original passages and to each other. Furthermore, the source of most responses could be located in the passages. The methods of scoring and matching the responses

could be made tighter and more rigorous, but with probably little gain in the reliability of this particular set of results.

In terms of the sources of theme and topic information and the strategies for identifying thematic information, the appearance of thematic information early in the passage was confirmed, and the expectation that theme identification would be more difficult than topic identification was also confirmed. However, there is no clear cut result that shows that themes were more variable than topics.

The major hypothesis about the relation of topics and themes was strongly confirmed: Most themes contained one of the topics, and most of the time as a surface subject. The more often an argument appeared as a topic, the more often it appeared in a theme, especially as a surface subject.

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